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## Ground State Cooling of the Radial and Axial Modes of a Single Ion in a Penning Trap

Following results of laser cooling a single ion of  $^{40}\text{Ca}^+$  to its motional ground state ( $\bar{n}_z = 0.02(1)$ ) in the axial domain of a Penning trap [1], we report simultaneous sideband cooling of both radial modes to near their ground state in the same apparatus. Sideband cooling is performed on the  $S_{1/2} \leftrightarrow D_{5/2}$  electric quadrupole transition at 729 nm, and average phonon numbers for the magnetron and modified cyclotron modes are found to be  $\bar{n}_- = 0.7(2)$  and  $\bar{n}_+ = 0.3(1)$  respectively. The observation of Rabi oscillations in both the axial and radial domains shows that the electronic state of the ion can be coherently manipulated.

### Summary

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